NPS Photo by Rick Wood

Hidden Treasures

Lesson Objective: This lesson will increase a student's understanding of the process involved with, and the importance of, paleontological resources and fossil formation.

Key Concepts: fossils; volcanic fossils; rock cycle; rock cycle processes: cooling, weathering and erosion, compaction and cementation, heat and pressure, melting; packrats; cave animals classification: trogloxene, troglophile, and troglobite; midden; amberat; radio carbon dating.

Duration: 1 55-minute class period

Audience: Middle school and high school students

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Teacher Copy, Answer Key, and Activity Fact Cards

HIDDEN TREASURES- TEACHER COPY

Activity #1: THE WASP

The age of fossils and the rocks in which they are found are important in telling us about historic environments. Explain how fossilized organisms, such as this wasp, can help scientists learn about the organisms and the environment they once lived in.

Example answer:

By studying the fossil record we can tell how long life has existed on Earth, and how different plants and animals are related to each other. Often we can work out how and where they lived, and use this information to find out about ancient environments. The most direct information the fossil record provides is of an organism's physical structure and what it may have looked like, thereby enabling it to be classified. Other information such as its environment, its diet, and its life cycle is deduced from its physical attributes, from other fossils found in association, and from the types of rocks containing the fossils.

Activity #2: The Rock Cycle

The rock cycle is a model of how the Earth's geological processes create, modify, and destroy rocks.

Use the following terms to correctly label the rock cycle.

Cooling	Sediments	Compaction & Cementation
Igneous Rock	Heat & Pressure	Metamorphic Rock
Melting	Sedimentary Rock	Weathering & Erosion

1. Magma
2. *Cooling*
3. *Igneous Rock*
4. *Weathering & Erosion*
5. *Sediments*
6. *Compaction & Cementation*
7. *Sedimentary Rock*
8. *Heat & Pressure*
9. *Metamorphic Rock*
10. *Melting*

Summary:

Using the rock cycle handout and your answers from above as guides, summarize the processes of the rock cycle. **Start with the formation of magma** and work your way through the cycle.

The rock cycle starts with molten rock (magma), which cools to form igneous rocks. These rocks weather and erode, and the eroded material is called sediments. These sediments are compacted and then cemented into sedimentary rocks. Then these sedimentary rocks are subjected to heat and pressure, which forms metamorphic rocks. Eventually, these metamorphic rocks may be heated to the point where they again melt into magma.

Activity #3: Volcanic Fossils

Students may benefit from having the "Views" Florissant Fossil Beds Virtual Experience on a computer for them to reference during the activity. If a computer is available, use the following links to access the appropriate section:

1. Access the Views website: http://www2.nature.nps.gov/views/#
2. Click on "Multimedia Version"
3. Click on "Virtual Experiences"
4. Click on "Florissant Fossil Beds"
5. Click on "Introduction"
6. Click on "Tours"
7. Click on "Eocene Epoch"
8. Click on "Geologic Story"

Card Title	Summary of Events
Florissant Valley	The mountain meadows of the Florissant Valley are home to a variety of fossils and fossils.
Volcanic Activity	A series of volcanic eruptions in the Florissant Valley created the conditions needed for the formation and preservation of fossils.
Mudflows	Volcanic mudflows are called lahars, and they are a mixture of sediment and debris. Lahars flowed down and buried the trees.
Fossilized Trees	The silica-rich lahars preserved the trees through "permineralization", which is a type of fossilization.
Lake Formation	Another lahar flowed through the valley blocking the stream and causing the water to back and form lakes within the valley.
Raining Ash & Clay Lakes	The volcanic complex remained active for many years and subsequent eruptions released ash and pumice into the air. Rain washed the ash into the lake where it became clay.
Trapped!	Organisms settle into the clay at the bottom of the lakes.
The Formation of Fossils	The layers of organisms in the clay built up and over time compacted into shale. The formation of the shale created carbonized compressions and impression fossils of the organisms trapped inside.
Fossil Protection	A final lahar formed a protective caprock that helped shield and protect the fossils.

*** A pictorial answer key is also provided. ***

Activity #4: PACKRATS

Cave animals are categorized based on the amount of time they spend in caves. There are three categories of cave animals: **trogloxenes** (cave visitors), **troglophiles** (animals that spend considerable amounts of time in caves, but are not dependent on them), and **troglobites** (animals that are found exclusively in caves). Packrats, also known as woodrats and trade rats, are trogloxenes and their visits to caves have huge impacts on the paleontological resources.

This activity will introduce you to these furry cave guests and help you understand their affects on cave fossils.

WE SUGGEST HAVING THE STUDENTS TAKE TURNS READING THE PACKRATS HANDOUT ALOUD TO THE OTHER GROUP MEMBERS.

1.) What terms describe the following types of cave dwellers?

- Animals that are found exclusively in caves: *TROGLOBITES*
- Animals that periodically visit caves: *TROGLOXENES*
- Animals that love caves: *TROGLOPHILES*

2.) What are packrat nests called? *MIDDENS*

3.) Name 4 objects that could possibly be found in a packrat nest:

- *BONES*
- *PLANT MATERIAL*
- *STICKS*
- *SPOON OR WATCH*

4.) True or False: Packrats only use their nest once and build a new one year after year. *FALSE*

5.) True or False: Packrats urinate on their nests. *TRUE*

6.) What is amberat? *WHEN PACKRAT URINE HARDENS OVER TIME IT HAS A GLOSSY, HARD YELLOW APPEARANCE WHICH IS CALLED AMBERAT.*

7.) What is a technique that researchers have used to find out how old a packrat nest is?

RADIO CARBON DATING

NPS Photo by Rick Wood

Hidden Treasures

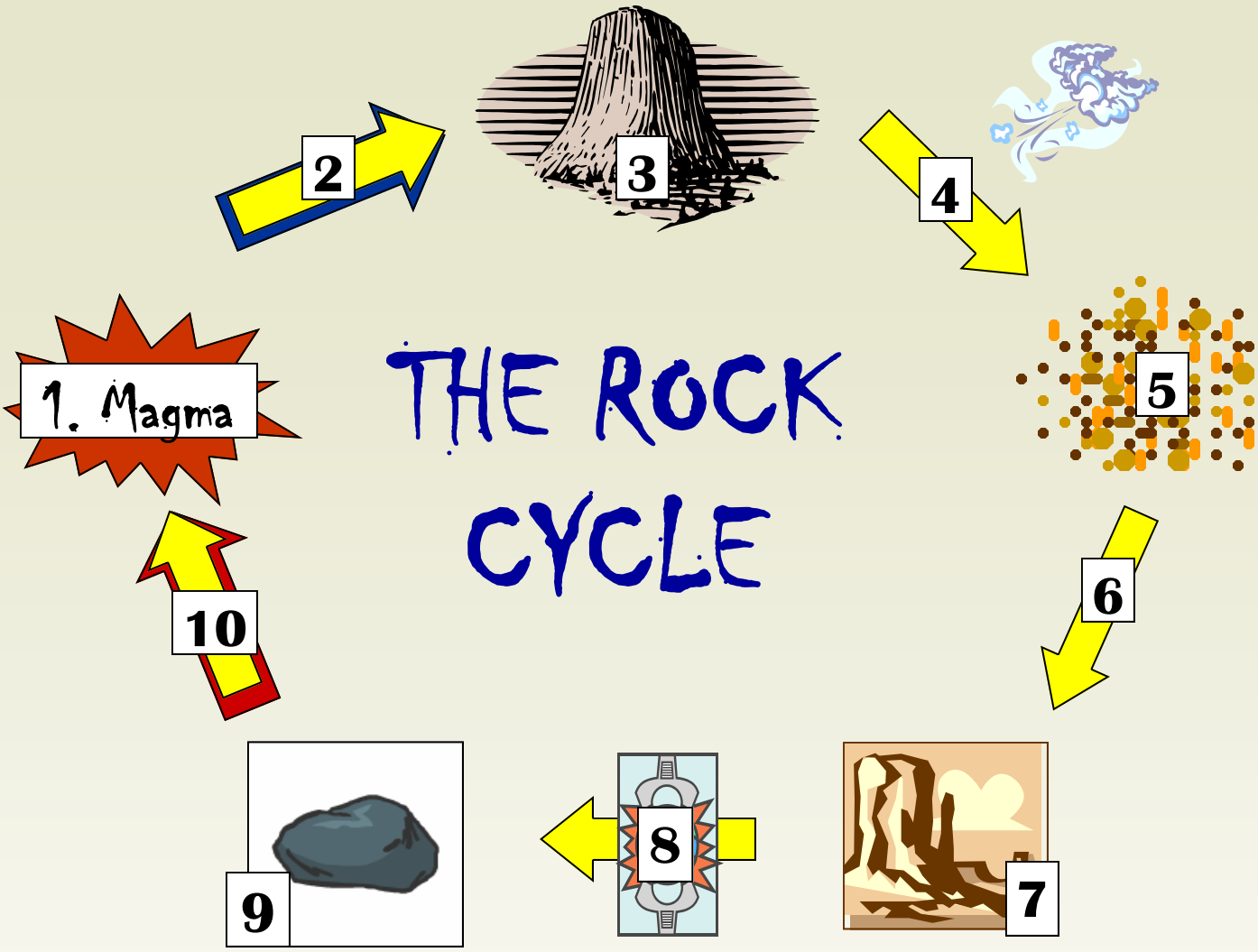
Activity Fact Cards

THE WASP

Photo courtesy of Florissant Fossil Beds National Monument

This is a photograph of a fossilized wasp found in Florissant Fossil Beds National Monument. Explain WHAT and HOW fossilized organisms, such as this wasp, can tell us about the environment they once lived in.

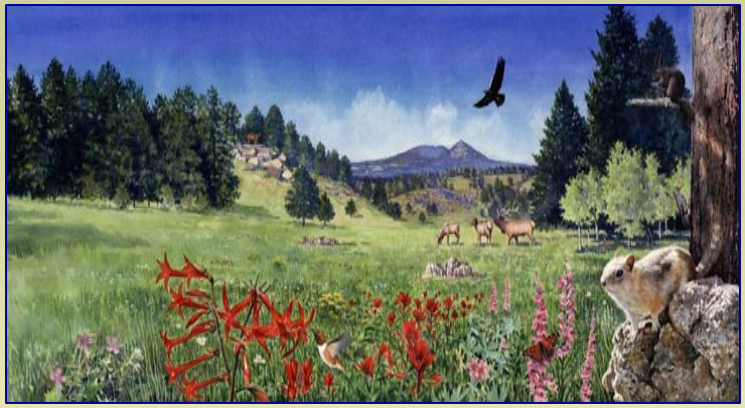
THE ROCK CYCLE



USE THE FOLLOWING TERMS TO LABEL THE ROCK CYCLE

Cooling	Sediments	Compaction & Cementation
Igneous Rock	Heat & Pressure	Metamorphic Rock
Melting	Sedimentary Rock	Weathering & Erosion

Florissant Valley

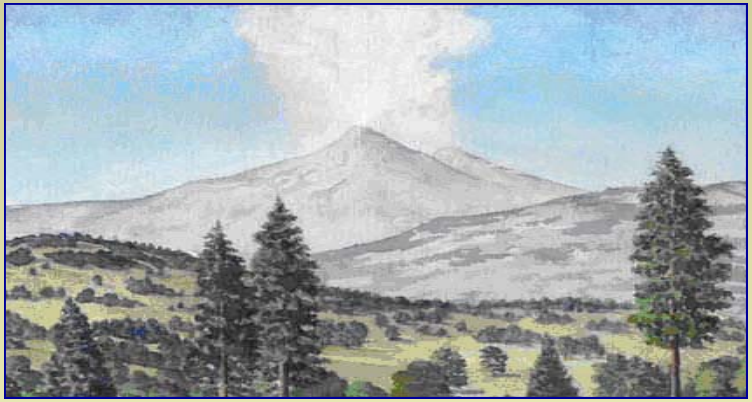


Original artwork by Rob Wood

The mountain meadows and forests of Colorado's Florissant Valley are home to a variety of wildlife.

The valley is also rich in fossils.

Volcanic Activity



Original artwork by Rob Wood

A series of volcanic eruptions occurred in the Florissant Valley during the Eocene Epoch.

These eruptions created the conditions needed for the formation and preservation of fossilized organisms.

Mudflows

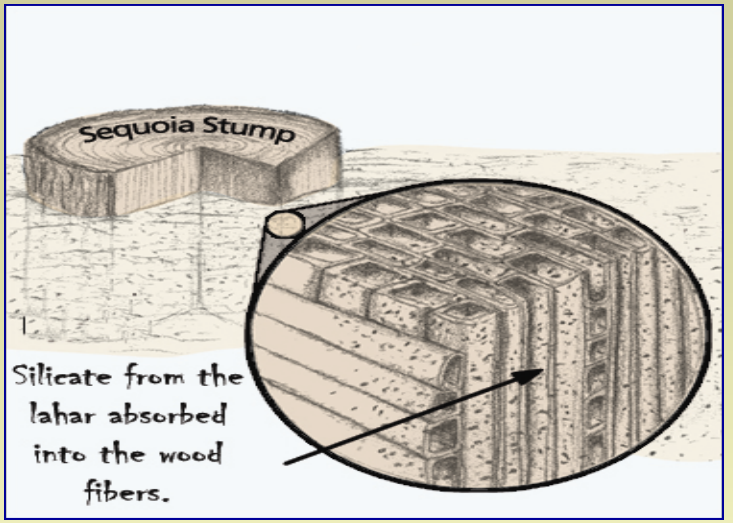
Original artwork by Rob Wood

The eruptions in the Florissant Valley created mudflows called *lahars*.

Lahars are a mixture of volcanic sediments and debris.

These lahars flowed down from the volcano and buried the surrounding trees.

Fossilized Trees



Original artwork by Linda Lutz-Ryan

The burial in the silica-rich lahar preserved and fossilized the tree trunks through a process called "permineralization".

Permineralization is a type of fossilization where the original hard parts of an organism have additional mineral material deposited in their pore spaces.

Source: Bates and Jackson (1984)

Lake Formation

Original artwork by Rob Wood

After the burial and preservation of the trees, another lahar flowed through the valley and blocked the stream.

With no escape path, the stream backed up and filled the valley with water. This surplus of water formed lakes in the valley, such as the ancient Lake Florissant.

Raining Ash & Lakes of Clay

Original artwork by Rob Wood

Following the formation of the lakes, the volcanic complex remained active for many years.

Subsequent volcanic eruptions released ash and pumice into the air.

Rainstorms would then wash the ash into the lakes where it settled to the bottom and eventually became clay.

TRAPPED!

Original artwork by Rob Wood

Many organisms settled to the bottom of the lakes and became buried in the clay.

Insects and plant parts (leaves, cones, berries) settled to the bottom in great numbers.

Fish, mammals, and other creatures living in the area also settled to the bottom of the lakes.

THE FORMATION OF FOSSILS

NPS Photos courtesy of Florissant Fossils Beds National Monument

The layers of organisms and sediments buried in the clay built up and were compacted and cemented into *shale*.

The formation of the shale created carbonized compressions and impression fossils of the organisms trapped inside.

Fossil Protection

Original artwork by Rob Wood

A final lahar covered the shale and formed a protective *caprock*.

This caprock shielded the shale from erosion and helped to preserve and protect the fossils.

Answer Key

1

Florissant Valley

The mountain meadows and forests of Colorado's Florissant Valley are home to a variety of wildlife.

The valley is also rich in fossils.

2

Volcanic Activity

A series of volcanic eruptions occurred in the Florissant Valley during the Eocene Epoch. These eruptions created the conditions needed for the formation and preservation of fossilized organisms.

3

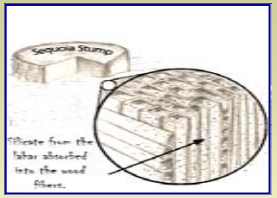
Mudflows

The eruptions in the Florissant Valley created mudflows called *lahars*.

Lahars are a mixture of volcanic sediments and debris.

4

Fossilized Trees



The burial in the silica-rich lahar preserved and fossilized the tree trunks through a process called "permineralization".

Permineralization is a type of fossilization where the original hard parts of an organism have additional mineral material deposited in their pore spaces.

Source: Bates and Jackson (1984)

5

Lake Formation

After the burial and preservation of the trees, another lahar flowed through the valley and blocked the stream.

With no escape path, the stream backed up and filled the valley with water. This surplus of water formed lakes in the valley, such as the ancient Lake Florissant.

6

Raining Ash & Lakes of Clay

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Rainstorms would then wash the ash into the lakes where it settled to the bottom and eventually became clay.

7

Trapped!

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Insects and plant parts (leaves, cones, berries) settled to the bottom in great numbers.

Fish, mammals, and other creatures living in the area also settled to the bottom of the lakes.

8

The Formation of Fossils

The layers of organisms and sediments buried in the clay built up and were compacted and cemented into *shale*.

The formation of the shale created carbonized compressions and impression fossils of the organisms trapped inside.

9

Fossil Protection

A final lahar covered the shale and formed a protective *caprock*.

This caprock shielded the shale from erosion and helped to preserve and protect the fossils.

Photos by Rick Olson

Packrats

Packrats are small mammals that collect objects to build their nests, which are called middens. These opportunistic creatures will pick up anything they find, including plant matter, bones, vegetation, and other available material. Packrats find an object, such as a piece of cactus, and scurry back to their home with it in their mouth. If they find something better along the way, they drop their current treasure and trade it for the new object. Many a miner or camper in the past has awakened to find a cone or stick in place of a spoon or watch.

Generations of packrats can live in the same area, building middens of tremendous proportions. Some are 5-feet tall and 10-feet wide. These middens are fortresses of tangled vegetation, bones, sticks and other items that are held together by organic glue…the urine of the packrat. This urine hardens over time and because of its glossy, hard yellow appearance, is called *amberat*. Analysis of the amberat can offer insights into the physiology of the packrats themselves.

Middens have persisted for thousands of years, becoming storehouses of scientific information. Researchers have used radiocarbon dating to discover some middens over 35,000 years old! Paleoecologists study ancient middens to research ancient climates, and biologists can use middens to determine what species lived in an area thousands of years ago. Its exciting to think that there are still more discoveries to be found in these biological warehouses.

NPS Photo by Rick Wood

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Student Copy

HIDDEN TREASURES

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The rock cycle is a model of how the Earth's geological processes create, modify, and destroy rocks.

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Igneous Rock	Heat & Pressure	Metamorphic Rock
Melting	Sedimentary Rock	Weathering & Erosion

1. Magma
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Summary:

Using the rock cycle handout and your answers from above as guides, summarize the processes of the rock cycle. **Start with the formation of magma** and work your way through the cycle.

Activity #3: Volcanic Fossils

The environment where a fossil is found can sometimes tell us how that fossil was formed. For example, fossils found within the structural rocks of caves have been preserved within the cave-forming rock. Fossilized insects found in amber were once stuck in the sap of trees, and when the sap turned into amber the insect was trapped inside. Volcanic activity can also produce the necessary conditions for the formation of fossils.

In this activity we will use the explosive history of the **Florissant Fossil Beds National Monument** as an example of how volcanoes can create and conserve fossils. Read through the provided information cards and put them in the correct geological order. Once you have them in order, fill in the titles of the cards in the boxes on the left and summarize the cards on the right.

Card Title	Summary of Events
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

Activity #4: Packrats

Cave animals are categorized based on the amount of time they spend in caves. There are three categories of cave animals: **trogloxenes** (cave visitors), **troglophiles** (animals that spend considerable amounts of time in caves, but are not dependent on them), and **troglobites** (animals that are found exclusively in caves). Packrats, also known as woodrats and trade rats, are trogloxenes and their visits to caves have huge impacts on the paleontological resources.

This activity will introduce you to these furry cave guests and help you understand their affects on cave fossils. Read the information on the Packrats handout and then answer the questions below:

1.) What terms describe the following types of cave dwellers?

- Animals that are found exclusively in caves: _____
- Animals that periodically visit caves: _____
- Animals that love caves: _____

2.) What are packrat nests called?

3.) Name 4 objects that could possibly be found in a packrat nest:

- ▫
- ▫
- ▫
- ▫

4.) True or False: Packrats only use their nest once and build a new one year after year.

5.) True or False: Packrats urinate on their nests.

6.) What is amberat?

7.) What is a technique that researchers have used to find out how old a packrat nest is?

NPS sketch: Craters of the Moon National Monument and Preserve